Land Cover and Land Use Change Science: needs from the Landsat Program

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Landsat Science Mission

- The LCDM is primarily a science mission - providing a continued time series and as a result data product continuity is essential
- Landsat provides critical observations for global change research on land use and land cover change and others topics
- Important components of the science mission for Landsat include:
  - Providing a long-term global database on land use and land cover change (seasonal hot spots, interannual and decadal changes and trends) as a basis for:
    - quantifying land cover extent and characteristics, location and rates of change,
    - developing an empirical understanding of the processes of change,
    - parameterizing mesoscale ecosystem process and hydrological models
    - and driving and validating predictive land use models

Landsat Science Mission (cont'd)

- Providing the high resolution component of a multi-scale terrestrial observing system complementing and validating land cover and land use data sets from moderate resolution sensing systems (e.g. AVHRR, MODIS, NPP) and their associated interim products (e.g. surface reflectance, land surface temperature, fire occurrence)

Landsat has a history of dynamic product continuity allowing instrument evolution and improvement – MSS>TM>ETM>?

Programmatic Relevance of Landsat Observations

- NASA: ESE - Land Cover and Land Use Change Program
- USGCRP Second Decade
  - Research Element on Land Use and Land Cover Change
  - Research Element on Carbon Cycle
- IHDP/IGBP - Land Use Cover Change
- Global Terrestrial Observing System (Global Terrestrial OS) – Global Observations of Forest Cover (GOFC)
- Policy Kyoto Carbon Accounting – land use/forests
- Emphasis on regional analyses and science networks

Key Characteristics to Achieve the Science Mission

- **Science Quality Data**
  - LCDM will provide systematic high-resolution scientific measurements
  - Calibrated data and stability - calibration needs monitoring during mission life – relationship to previous sensors must be established - Timely availability of calibration analyses
  - Radiometric Performance similar to MODIS, allowing MODIS validation
  - Geolocation – onboard system (reducing the emphasis on ground processing and use of GCP's)
  - Operational data quality assessment needed for LCDM products
  - Need a Science Review of the Specification (Series of Technical Workshops with the Science Community, as was done for Landsat 7)

Key Characteristics to Achieve the Science Mission (cont'd)

- **Global Acquisition Strategy**
  - Nominal 4 times per year for the entire land surface (<10% cloud cover) optimized for land cover discrimination
  - Higher frequency in identified hot spot regions
  - On-demand acquisition – providing higher temporal resolution for process studies and field campaigns
  - An acquisition strategy designed to meet science needs
- **Non-prohibitive Cost of Data**
  - Need data to be affordable
  - Costs Non prohibitive to science users with volume data needs (e.g. @ $50 per scene - 300 scenes = $15,000)

Key Characteristics to Achieve the Science Mission

- **User Oriented Data System**
  - Search and Browse – suited to large volume time and space searches
  - Timely availability – rapid response for field campaigns
  - Electronic product access
  - Historical archives maintained, easily accessible and affordable
- **Data Policy**
  - Open sharing of data once purchased - to enable broad collaboration (within and between projects and PI's) e.g. allowing verification of scientific results

Desirable Improvements for an LCDM

Examples:

- Signal to Noise closer to stated goal in the data specification for typical values (i.e. 10-11 bit quantization)
- Additional higher-order products with known accuracy subject to science peer-review e.g. surface reflectance, terrain corrected products
- Explore Onboard Processing to reduce ground system processing e.g. cloud cover
- Improved partnerships with non-NASA ground stations, providing increased opportunities for cloud free acquisition

The various suggestions for improvements need to be compiled and be subject to broad discussion and review

Need to distinguish between essential and desired improvements

Transition Systematic Global Change Measurements to Operational Systems

- NASA Easton Planning meeting identified two types of systematic science measurements (moderate and high resolution) in the 2005 time-frame
- NPP VIIRS provides a bridging mission between MODIS and NPOESS (the next generation operational system)
- The LCDM should bridge between ETM and a US Operational Landsat (high resolution) System - we cannot continue with ad-hoc gap-filling Landsat Missions – the data record is in jeopardy - the time has come for an operational high resolution system
  - **Guaranteed long term measurements – reliable data record**
  - **Associated government agency responsibility**
  - **Dynamic data continuity (allowing instrument improvements) over previous missions**
  - **Multiple instruments built and ready for use – replacement process based on sensor performance**
  - **NRC suggested possibility of collocation of Landsat with NPP**

How Might a Commercial Data Buy Satisfy Science Needs

- Based on previous experience with Landsat commercialization – I am skeptical that a commercial data buy could meet all the science needs as specified.
  - **We are just starting to overcome the negative impact of previous commercialization on the use of Landsat data for scientific purposes i.e. seeing an increasing number of Landsat science users and Landsat publications in the science literature and increasing capacity for regional analyses and volume processing, more widespread international scientific use of Landsat data**
  - **It is unlikely that simply defining the data product will provide the science community with what is needed**
- The current Landsat 7 data policy is serving the science community well and must be kept intact !!

How Might a Commercial Data Buy Satisfy Science Needs - Cont'd

- At this time I do not see a commercial partner capable of satisfying all the previously stated needs of the science community, ***however commercial partnerships are desirable*** and could strengthen the Landsat program, some potential areas for commercial partnerships include:
  - **building the satellites, the platforms, the ground systems**
  - **commercial provision of *value added* data products (e.g. image mosaics), analysis software and services (e.g. RS/GIS).**
  - **commercial provision of *customized products* or *on demand processing* of L3 products e.g. snow cover, forest area – a partnership with the science community could help develop these scientifically useful product**
  - **boresited 1–3m sensor with a 30m on the next Landsat instrument - provision of commerical *1m-4m data with value added products* could be attractive to the private sector and could also meet science data needs (as currently being undertaken by the NASA Commercial Data Buy)**

Landsat is a National Asset

- Landsat will play a critical role in the next two decades of global change research – we cannot afford an experiment that fails – we do not want a step back from ETM
- Whichever solution is defined for the LCDM must maintain the integrity of the system for providing science quality measurements, affordable data, accessible archives and data sharing to enable the science to be done.
- From the science perspective, we need equal attention to and science review of the instrument design, the instrument performance, the data system AND the products
- For the NASA LCDMission - the science must drive the design and implementation – need to look carefully for any contradictory Natural Resource Management requirements
- The National and International Global Change Research Communities are depending on the continuation of the Landsat Program